

Claims

1. An optical repeater, comprising:

at least four optical amplifiers each supplying optical amplification to an optical signal traveling in a different unidirectional optical fiber that collectively form at least two bi-directional pairs of optical fibers;

a first plurality of pump sources for providing pump energy to a first optical fiber located in a first of the optical fiber pairs and a second optical fiber located in a second of the optical fiber pairs, said first optical fiber and said second optical fiber supporting optical signals traveling in a common direction;

a first combiner arrangement combining the pump energy from the first plurality of pump sources and distributing it to the optical amplifiers supplying amplification to optical signals traveling in the first and the second optical fibers;

a second plurality of pump sources for providing pump energy to a third optical fiber located in said first optical fiber pair and a fourth optical fiber located in said second optical fiber pair, said third optical fiber and said fourth optical fiber supporting optical signals traveling in a common direction that is opposite to that of said first and second optical fibers; and

a second combiner arrangement combining the pump energy from the second plurality of pump sources and distributing it to the optical amplifiers supplying amplification to optical signals traveling in the third and the fourth optical fibers.

2. The optical repeater of claim 1 further comprising a first passive coupling arrangement for conveying excess pump energy that traverses the optical amplifiers in the first and the second optical fibers to the third and the fourth optical fibers at a location upstream from the optical amplifiers supplying amplification to optical signals traversing the third and the fourth optical fibers.

3. The optical repeater of claim 2 further comprising a second passive coupling arrangement for conveying excess pump energy that traverses the optical amplifiers in the third and the fourth optical fibers to the first and the second optical fibers

at a location upstream from the optical amplifiers supplying amplification to optical signals traversing the first and the second optical fibers.

4. The optical repeater of claim 1 wherein said optical amplifiers are rare-earth doped optical amplifiers.

5. The optical repeater of claim 4 wherein said rare-earth doped optical amplifiers are erbium-doped optical amplifiers.

6. The optical repeater of claim 1 wherein said first combiner arrangement includes a first combiner and a first plurality of couplers coupling pump energy from said combiner to the first and the second optical fibers.

7. The optical repeater of claim 6 wherein said second combiner arrangement includes a second combiner and a second plurality of couplers coupling pump energy from said second combiner to the third and the fourth optical fibers.

8. The optical repeater of claim 7 wherein said first and second combiners are 2x2 combiners.